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# Economics of a Baltic Sea Sustainability Approach

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With 8 Figures and 4 Tables

Key words: Baltic Sea region, sustainability, uncertainties, institutional economics, funding

## Abstract

Politics, economics and science interpret the concept of sustainability differently. The discussion distinguishes between economic, environmental and social sustainability. While advocates of economic sustainability assume that natural capital is substitutable by human-made capital, policies for a sustainable development are questionable. The paper therefore highlights a regional case to show that sustainability is indivisible. Moreover, economics and policies serving Baltic sustainability need a new institutional network to manage the multispecies resource with participation of the social players and by addressing targets step by step. The findings are based on a simple ecological-economic model providing insights for the negotiation game for all players. In addition, multispecies resource management shows a strong hierarchy in both social actions and targets. Since sustainable development is an on-going, dynamic process, policy implementation and funding must also be continuous. Sustainable development therefore challenges the institutional sets for the process and its relations to local, regional and national policies.

## 1. Introduction

In 1992 the Diplomatic Conference on the Protection of the Marine Environment of the Baltic Sea Area established *The Baltic Sea Joint Comprehensive Environmental Action Programme* (JCP) for the renovation of the Baltic Sea within the framework of the (second) *Convention on the Protection of the Marine Environment of the Baltic Sea Area,* 1992. This program aimed at reducing nutrient loads in the term 1993–2012 to "assure the ecological restoration of the Baltic Sea, ensuring the possibility of self-regeneration of the marine environment and preservation of its ecological balance" (HELCOM 1992). Referring to the need for pollutant-specific reduction rates of at least 65% or a total ban on some substances[1]), this target may be sufficient for "environmental sustainability", but clearly neglects other aspects of "sustainability".

"Sustainability" is a concept with different meanings for natural scientists, social scientists and policy makers. Summarizing the discussion, GOODLAND (1995) distinguishes between economic, environmental and social sustainability, and also between "weak", "strong" and "absurdly strong" sustainability concepts. Evidently, in view of this diversity, the set targets and possible outcomes must always be taken into account when considering sustainability, and it must always be remembered that the way sustainability is defined may be strongly influenced by the goals set by the social players. *Economic sustainability* bases on a "capital" substitutability theory (SOLOW 1974) mainly, but *social* and *environmental sustainability* concepts also take social and environmental equity, cultural and biological diversity into account and at least some ethical considerations. In other words, the *economic sustainability* approach as a comprehensive concept for the sustainable development of a particular region is an oversimplification. Moreover, it does not fit to the political goal of the Baltic Sea Convention, which focuses on

(1) "... the indispensible values of the marine environment of the Baltic Sea Area, its hydrographic and ecological characteristics and the sensitivity of its living resources to changes in the environment ..." and,

(2) "... in mind the historical and present economic, social and cultural values of the Baltic Sea Area for the well-being and development of the people of that region ...".

[1]) "critical nutrient loads" ... *(safe minimum standards)* ... To bring the Baltic back to its relatively clean state of 1950, nutrient discharges would have to be reduced to the level they were during the 1930s and 1940s, i.e. around 350 000 tons of nitrogen and 15 000 tons of phosphorous per year. For nitrogen (nitrate and ammonia) – this means a reduction of some 65% and for phosphorous, 80% based on today's nutrient loading estimates which are by no means exact." (HELCOM 1990).

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The first of these goals refers to the biophysical limits of the ecosystem and the second reflects values based on DALY's socioethical complex (1977). Hence, bearing in mind the two aspects of the political target, the convention focuses on *sustainability* rather than simply restoration of the Baltic Sea Area. However, if we add the rights of future generations, the goals include all components of the WCED (1987) definition of sustainable development.

Since the economic, cultural and political development of the Baltic Sea Region is also crucial to sustaining the economic and social performance of the region and to restoring the ecological balance of the Baltic Sea ecosystem, the development of the national economies and local policies are obviously of foremost importance. Therefore, the paper first discusses sustainability concepts. It then briefly describes the economic and ecological background that must be taken into account before discussing the mitigation targets needed to restore the ecological balance in the context of an economic indicator system. Last, but not least, the paper proposes a joint project to provide a financial infrastructure for the Baltic Sea restoration process. Finally, the paper focuses on a new institutional framework to overcome the obstacles of the present situation and to open the floor for social player network participation. Therefore, the paper strongly reflects the findings concerning cooperative behaviour in water-use cases which have been described as being sustainable in certain regions (OSTROM 1992).

## 2. Sustainability – the predetermination of targets or what does sustainability mean?

The goal of *economic sustainability* is to make "the economic capital ... stable." (GOODLAND 1995). This concept bases on SOLOW's substitutability theory (1974) that is human made capital may substitute completely for natural capital. Consequently, "... the optimal policy for each generation is to maintain the existing capital stock. Investment should be exactly equal to depreciation. Now the important property of a homogenous capital stock is that each component of that stock is perfectly substitutable for all components ..." (COMMON & PERRINGS 1992). Since, current and future generations will be better off in the sense of this rule, the better opportunities basing on human-made capital independently of nature will make natural capital – such as the Baltic Sea – superflous. Consequently, in the case of the Baltic Sea region there is no need to protect the Baltic Sea environment. This shows clearly that the neoclassical sustainability approach is an oversimplification and does not support the Baltic Sea sustainability approach.

*Environmental sustainability* "seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that sinks for human wastes are not exceeded in order to prevent harm to humans. Humanity must learn to live within the limitations of the biophysical environment. *Environmental sustainability* means that natural capital must be maintained, both as a provider of inputs and as a "sink" for wastes. This means holding the scale of the human economic subsystem to within the biophysical limits of the overall ecosystem on which it depends. *Environmental sustainability* needs sustainable production and sustainable consumption" (GOODLAND 1995). GOODLAND relies strongly on DALY's (1973) "steady-state" concept and believes that "maintaining a certain scale of human-ecosystem interaction" will ensure the sustainability of the environment. More simply, this means that the biophysical limits must be known to ensure that they are not exceeded. Then, *environmental sustainability* will be a sure outcome of this process. However, this concept neglects the systems' inherent uncertainties. Moreover, it is based on the basic, but empirically disproved assumption of neoclassical economics that all players possess perfect information. In addition, it ignores further uncertainties due to system properties such as nonlinearity, complexity and change. Moreover, the *environmental sustainability* concept stems from basic economics and the assumption that sustainability can be attained by simply reallocating resources. Still, GOODLAND's concept has the advantage that it outlines a certain amount of capital that is not easily substituted – natural capital. This makes it more far-reaching than the economic sustainability concept. However, it cannot explain how to deal with the human impacts on the local, regional and global environment which already completely or partly destroyed natural ecosystems or explain how to respond to non-linear changes in natural and social systems.

*Social sustainability* can be ".... achieved only by systematic community participation and strong civil society. ... This "moral capital" ... requires maintenance and replenishment by shared values and equal rights, and by community, religeous and cultural interactions ..." (GOODLAND 1995). This clearly points to at least two crucial aspects of a Baltic Sea sustainability approach: first, participation on the basis of a set of equal rights, and second the combination of environmental and social targets to sustain the Baltic Sea environment.

The paper will now focus on the roots of the sustainability concept, obstacles to its previous stages and a basic set of components and indicators.

## 3. Sustainability – from carrying capacity to resilience, from resource use towards equity, ethics and participation

Sustainability as a concept was first mentioned in the writings of MILL (1848) and MALTHUS (1836) (cf. GOODLAND 1995). FAUSTMANN used the concept in 1849 to calculate forest rotation periods to maximize the returns (cf. LUDWIG 1993). Later, economists elaborated the *Maximum Sustain-*

*able Yield concept* (MSY; cf. PEARCE & TURNER 1990) for managing the use of renewable resources. The concept in general is strongly reductionist in its treatment of environmental variability. Moreover, it can only be applied in a one-resource-as-commodity approach.

Hence, it unavoidably leads to the term *carrying capacity*. The *carrying capacity* is the maximum stock of a certain population that can be supported by an ecosystem: a given stock (i.e. a certain bacterial, plant, animal or human population) can exploit the structural and functional constraints (space, food, predation etc.) of its ecosystem until the system cannot supply additional members of the population with food, space or other needs without losing part of its properties or stability or being shift to another level of stability or even to another state of equilibrium. This concept reflects at least one component of the sustainability concept: the non-overexploitation rule. However, it does not completely explain system sustainability, although it is part of the definition (DALY 1977). Moreover, its use also entails uncertainties.

Living systems show natural fluctuations. The *carrying capacity*, therefore, is rather a concept than a quantity – like DALY´s pullmoll line (DALY 1987). The *carrying capacity* is a non a stable "crossline", but fluctuates, e.g. within in annual climatic boundaries. Moreover, it is a concept basing on different constituents and depends on system scales and properties such as extension, number of hierarchic levels, seasonal changes etc.

Since systems are known to change in time, for instance by cyclic behaviour (HOLLING 1986), the *resilience* concept was introduced to replace or supplement the *carrying capacity* concept. Its main advantage is that it can also explain certain levels of a systems' stages (equlibria). Each stage may be stable or sustained by internal and external factors for a certain time as long as "... the magnitude of disturbance ... can be absorbed before a system changes its structure by changing the variables and processes that control behavior. Resilience is the ability of a system to absorb perturbations" (BERKES & FOLKE 1994). Therefore, the *resilience* concept may be applied to the human-environment-impacts system in a more consistent way. However, the *resilience* concept may also be used to broaden the GOODLAND-concept to take into account a third crucial class of system components (BOULDING 1966): information. Previous definitions of sustainability only refer to matter and energy as suppliers for production and consumption (scale of inputs) and the absorbtion of wastes (matter and entropy, scale of outputs).

The *resilience* concept reflects the need to protect, for instance, a minimum level of population, biodiversity, cultural diversity, values etc., between some lower and upper limit. In other words, sustainability must focus not only on preventing upper limits of the life support system from being exceeded, but also on the protection of diversity and values as components that are crucial to system survival, i.e. on protection of the information pools (genome of the ecosphere and *memom* of human societies; DAWKINS 1991; KÖHN 1998).

But substituting the *resilience* concept for *carrying capacity* leads to a crucial implication: sustainability does not imply perpetuation (COSTANZA & PATTEN 1995). System sustainability as a function therefore depends on the structure of all realized populations/properties in a particular system, their interactions, changes (adaptation, coevolution), etc., over time (3.1). $X_{min}$ represents the species reservoir of the biogeographic region in which the particular ecosystem is embedded or a set of human values in a particular region; $X_{max}$ is the conservation of the biological or cultural diversity and system function maximum. In addition, all populations (similar to multi-species resources, $p_{o...n}$), abiotic and deduced biological structures as well as social institutions ($s_{o...n}$), and their interrelations ($f_{o...n}$) are time related vectors (3.1).

$$F(t) = \int_{t=0}^{T} \int_{X_{min}}^{X_{max}} \varphi\,(p_{o...n}, s_{o...n}, f_{o...n}, u)\, dt \qquad (3.1)$$

This approach implies, first, that a shift from a one-resource to a multispecies approach has been undertaken; second, humanity is only one and not the sole aspect of the sustainability concept; third, that the concept includes biophysical and socioethical limits; fourth, that all components are time dependent vectors; and finally, that u stands for a systems' inherent uncertainties. However, in a *resilient* state predictions are possible at least in the short term or during periods of gradual change.

Finally, interactions within a range of sustainability representing the *resilience* of the environmental, social, and economic-political-cultural systems in the Baltic Sea area may be stabilized by *equity* and *participation* processes only. Therefore, *"social"* and *environmental ethics* are constituent parts of the Baltic Sea sustainability game. This means in the political sense that sustainability is a set of political actions within a framework of decision making processes which are aimed towards a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (cf. WCED 1987) which is based on natural and cultural values, technological knowledge and social institutions, at least in an ever changing environment, forced by human economic actions (BOULDING 1969).

## 4. The ecological background

The Baltic Sea is a semi-enclosed brackish water sea with a low, stable salinity in its main parts (surface salinity about 7–9%). It covers an area of 415,000 km$^2$ and has a volume of about 22,000 km$^3$. Like other regions, the Baltic started its self-generated system after the last glaciation about 12,000 years ago, and has since undergone many physical changes. The Baltic Sea is the largest truly brackish water system of the world that is connected to an ocean. It became stable from the biological point of view during the *Littorina*-Transgression in about 5,000 years BC. Consequently, from the evolutionary standpoint, the Baltic is a young ecosystem. The Baltic Sea is non-tidal, and the residence time is correspondingly long (25–40 years). Therefore, the Baltic has more of a stagnant than a through-flow character. The Baltic itself consists of several basins that differ in their hydrographic features. The narrow entrances to the Belt Sea region and the distinctive sills separating the basins from each other impede inflows of oxygenated salt water from the North Sea. Precipitation and a large fresh-water inflow from about 200 rivers (about 400–500km$^3$ fresh water input a year) lead to a stratified water column. Aperiodic inflows of salt water from the North Sea renew the salt water in the deep basins, but generate a strong halocline. This stratification hinders deep oxygenation, and some elements of the sea have been damaged owing to major economic impacts (e.g., HUPFER 1979; JANSSON 1978; HELCOM 1992a). The Baltic Sea resembles a storage basin for the discharges of civilization in the Baltic Sea drainage basin. The total environmental discharge into to the sea is estimated to consist of about 40% point-source pollution and 60% from diffuse pollutant sources (cf. HELCOM 1990).

# 5. The economic background

Since the Baltic Sea is a part of a larger Baltic environment occupying a drainage area of about 1,615,000 km$^2$, its health is affected by environmental impacts from at least nine littoral political states. In addition, parts of five other countries are also located in the Baltic Sea drainage area. The histories of these states, their social systems and their perception of environmental problems have diverged drastically at least since World War II. The Scandinavian countries (Sweden, Finland, and Denmark) and Germany developed into industrial nations. The East European countries (Poland, Lithuania, Latvia, Estonia and Russia), however, are currently experiencing a complex process of political, economical and cultural change started by the decline of the former socialist bloc in the late 1980s. However, human activities far outside the geographical confines of the Baltic area may also influence the Baltic environment: the region forms a substantial part of an emerging European unity, the boundaries of which are reflected in those of the political states composing it. Nevertheless, a historical Baltic Identity exists in cultural and economic life, based on tradition, trade, transportation, industries, agriculture, science, arts, etc. (SERAFIN & ZALESKI 1988).

However, the differences between the economies of the littoral countries are immense. While the Scandinavian countries and Germany have among the highest standards of living, productivity and wage levels in the world, these indicators have very low values in the eastern countries (HELCOM 1992b). Using the GNP-indicator[2]), the economically determined distance between these two groups is considerable (7.5 : 1). Moreover, the more or less identical growth rates of the GNP per capita indicator shows that a long-term convergence cannot be supposed.

Although the Baltic region was originally a resource supplier, a self-generating Baltic Economy emerged as a strong factor of the world's economy after World War II.

## 5.1 Environmental impact assessments

This chapter refers both to national impacts in relation to economic growth after World War II and to some sectoral impacts within the national economies.

### 5.1.1 Assessing the national impacts

The relative national environmental impacts were stated in a special report of the *Helsinki Commission* in 1990. The negotiation process by which the littoral states adopted the *Convention on the Protection of the Marine Environment of the Baltic Sea Area*, 1992, was based on this report. In addition, National Reports to the JCP give more detailed information on point-source and total pollution at national, subregional, and in some cases, local levels.[3]) Although these reports are partly accurate, estimation of total sewage discharges, for example, is impossible for at least two reasons. In the first place, most of the reports do not distinguish between industrial and municipal discharges and their compositions, and in the second, no total values are given for, say, BOD. This complicates the technological and costs planning processes besides making introduction of the *"polluter pays principle"* (PPP) difficult. In addition, the transition process in the former socialist countries is strongly affecting these figures. Some pollution is not produced continuously, so that it is well nigh impossible to design suitable technological remedies. Other potential pollution sources still exist, but the companies operating them no longer exist or have ceased trading. This situation poses a risk for investments. The risks in treating municipal sewage may be lower if a stable population in the city or region concerned is assumed. However, even the returns on investments in municipal sewage treatment equipment will depend on the budget available for enforcing PPP-strategies and, as shown in East Germany, the impact of a price setting system may even reduce total sewage discharge drastically. Therefore, planning authorities

[2]) There are serious problems in using this type of indicator (DALY & COBB 1986). However, it reflects "social inequity".

[3]) Detailed information in HELCOM (1992b), Background document for the Baltic Sea environmental Declaration, 1992. Conference document no. 5/2, Agenda Item 5, Table 3.

must design their technical and financial systems very carefully. Besides the ecologically desired targets, they must also take existing and developing institutional and social aspects as well as feedback impacts into account (cf. FREEMAN 1991).

Industrial growth rates were remarkably high in the former socialist countries because they started from a very low level of development. Investments in the heavy, textile and chemical industries led to high growth rates in the 1960s and 1970s. Therefore, these industries are technologically rather backward, and standard technologies to mitigate their environmental impacts were lacking. The rapid industrial development induced people to leave the countryside. Cities grew very quickly. Although, the demand for water is now more than 200 l a person per day, most sewage is still simply collected in sewerage systems. There was little or no environmental inducement to treat it. The result was a fairly strong environmental impact from both municipal and industrial effluents (see HELCOM 1992b).

Naturally, the northern and western countries also had a strong environmental impact on the Baltic. However, environmental awareness, early agreements (e.g. *Helsinki Convention* 1974; activities of the Nordic Council, National Environmental Programs) and the consequent investments mitigated the impacts to some extent once the programs were in place in the 1970s. The impacts from the northern and western industries stemmed mainly from the pulp and paper industries and from various metallurgical and chemical plants (HELCOM 1992b). However, these became less severe after legislation in the various states had forced industries to modify their processes and adopt environmentally sounder technologies in the 1970s. In addition, in the 1970s, the northern and western economies were already developing into service-orientated economies. Nevertheless, demand for energy and water for household purposes (laundry, domestic appliances, bathing, etc.) increased in these countries as standards of living improved. Water supplies and sewage disposal were not free of charge in these countries as they were in the former socialist countries. However, daily demand for of water does not reflect its true scarcity, and the average daily demand is currently about 150 to 200 l per person in these countries, too (cf. NIELSSON & BERGSTRÖM 1995). Since sewage treatment has become widespread, environmental impacts have decreased drastically. However, the Copenhagen sewage treatment plant, for instance was not complete until later in 1994. On the whole, however, the northern countries and West Germany were able to greatly reduce environmental loads from their municipalities and industries during the 1980s and 1990s.

However, this process was accompanied by the appearance of new sources and increased emissions from some sectors generating environmental loads. The increasing nitrogen inputs to the sea, for instance, stem mainly from electricity generation, transportation and run-off from agricultural land (HELCOM 1990).

5.1.2 Assessing the sectoral impacts

The growth of the chemical and petrol industries since World War II has affected the Baltic environment through at least three pathways. First, the discharge of industrial sewage has had a strong toxic impact on the rivers in the drainage basin, and consequently on the Baltic Sea. Second, the agricultural use of pesticides has introduced these substances to the food chain. And finally, atmospheric fall-out has led to persistent organic contamination. However, the environmental impact of most of these organic contaminants is still unknown. Pulp-bleaching, metallurgical and incineration processes also produce stable organic compounds as by-products (HELCOM 1990). Despite some uncertainty regarding their chemical transformation within the ecosystem, the environmental risks of these contaminants are becoming clear; e.g. infertility among seals and organochlorine concentrations in fish from the Baltic Proper that are still 3 to 10 times higher than in catches from the Atlantic Ocean (HELCOM 1990). No exact data are available for the impacts of specific substances. Moreover, the long residence times of some substances makes estimation of a separate damage function impossible.

Transportation accounts for 76% of $NO_x$ emissions in Norway, 65% in Germany, 68% in Finland, and 35% in the Eastern countries (HELCOM 1992; Institut der Deutschen Wirtschaft Köln 1995). Since about 60% of the total nitrogen load stems from airborne pollution, transportation is one, but not the only, source of diffuse inputs. About 60% of the total nitrogen impact to the Baltic Sea is airborne. Carbon dioxide output from transportation amounts to 28.5% of total carbon dioxide discharge in these countries annually. Despite this negative impact, shipping is among the beneficiaries of the Baltic Sea. About 350,000,000 tonnes of goods and 40,000,000 passengers are transported on the Baltic each year (BÖHME 1988).

A major contribution to mitigating the environmental impacts to the Baltic Sea should in fact be obtained from changes in agriculture. Airborne agricultural inputs amount on average to 30–35% of the nitrogen (approximately 400,000t/y) and 10% of the phosphrous (approximately 8,000t/y). Agricultural run-off varies within the drainage basin and is influenced quantitatively mainly by the kind of land use. It depends on farming intensity as and environmental conditions in the littoral countries. For example, average run-off is 24.22kg/ha*y in Denmark, but much lower in Poland (3.00kg/ha*y; HELCOM 1992b). In general, it can be assumed that fertilizer use in the Baltic region is about 5 Mio. t a year. Since productivity in the Eastern countries is only half that as in Western countries for cereals and 40% for root crops and tubers because only about 45% as much fertilizer is used per hectare, future environmental impacts from agriculture in the Eastern countries can be expected to increase. Moreover, taking livestock populations into account, impacts can be expected to increase through direct emission of nitrogen compounds, agricultural run-off from forage production and the discharge of manure.

Since industrial impacts stem from an unknown number of compounds, heat discharge, noise and industrial sewage, calculation of a total industrial impact is difficult. However, industrial processes are based on energy use, and it may therefore be assumed that carbon dioxide outputs are a suitable measure of industrial production. However, because industrial carbon dioxide output is decreasing in relative terms, absolute discharge figures must be used. In addition, coastal waters absorb carbon dioxide and stabilize the climatic conditions. Indeed, this is part of the utility function of the Baltic Sea.

The impacts of radioactivity and energy processing have not been assessed in a specific way. However, there is no doubt that, say, the discharge of cooling water can affect river ecosystems in the drainage area as well as the Baltic Sea ecosystem itself. Reports on existing depositories and landfills for radioactive substances draw attention to an additional unsolved risk potential that has yet to be taken into account.

Fisheries and tourism are the main beneficiaries of a healthy Baltic Sea. While fishery itself have a relatively small impact on the environment,[4]) tourism can affect ecosystems through discharges of sewage and waste in the same way as municipalities. Moreover tourism leads to increasing use of private means of transportation (s.a.).

### 5.2 Conclusions upon the economic impact assessment

In conclusion, the economic indicators at both national and sectoral levels show that the target of assuring "the ecological restoration of the Baltic Sea, ensuring the possibility of self-regeneration of the marine environment and preservation of its ecological balance" as stated in the *Convention on the Protection of the Marine Environment of the Baltic Sea Area*, 1992 cannot be reduced to technological mitigation strategies alone. Therefore, the institutional framework must ensure that, first, the socio-economic, second, technological-economic and third, ecological changes are monitored while simultaneously supporting a regional convergence process to ensure both intragenerational and intergenerational equity in the region. During the long-term adaptation process this will entail, total impacts may even become higher for certain substances, processes or economic sectors. Therefore, an information pool will be required to advise on investments in appropriate technologies, services and commodities for product specific, local and regional approaches.

[4]) Excluding fish processing.

## 6. The endangered ecosystem and its value

The ecosystem of the Baltic Sea is endangered by a huge variety of inputs. However, it still provides economic benefits in the form of seaborne transport, supplies of cooling water for energy production, fishing, recreation etc. In addition, further options for economic use and non-use values, like marine resource use and biodiversity (option and expectation values), may enhance the future utility of the whole Baltic region. One well known purpose of an option value about hundred years ago was the current economic use-value of tourism in this particular region. Currently, tourism accounts for about 20% of the economic benefits in the coastal region.

One can therefore assume that the littoral countries share a common interest in reducing impacts on the Baltic Sea environment. However, there are still several structural, functional and long-term uncertainties in both the ecological and the social system.

Estimations of the costs vary widely. While the High Level Task Force of the *Helsinki Commission* estimated that ECU 18 billion will be needed within a ten year schedule (i.e. ECU 1.8 billion a year); the *Stockholm Environmental Institute* calculated that ECU 7 billion will be needed annually for a 60 year schedule. The calculated total losses will, according to current estimates, be about 30 billion ECU a year for the coastal region only (this study). In fact, a total loss will not appear in all economic sectors at the same time. However, potential restructuring processes in the industrial sector, changes in agricultural practice, potential dematerialization strategies and changes in consumer behaviour all represent uncertainties that must be taken into account. However, there is little doubt, that "... a demand for higher standard of living similar to that in the western economies may result in an increase in pollution load to the Baltic Sea, due to higher energy and food production, etc." (WULFF & NIEMI 1992).

If the former socialist countries cannot adopt the most efficient technologies when restructuring their economies, environmental impacts can be expected to increase by at least about 40%. Consequently, the convergence process must be based on a new political, cultural/ethical, economic/technological and scientific way of thinking in order to avoid this increase and to orientate the societies around the Baltic towards a less resources-consuming lifestyle. Thus, the process of technological and economic/political transition will affect both the wealthy nations in the north and west and the eastern countries. Ultimately, the transition resulting from ecological necessity needs a cooperative system. Furthermore, a successful economical and political transition process in the former socialist countries may also influence economic competition within the Baltic region. Finally, the transition process in the Baltic region will be based on and constantly produce new structural, functional and long-term uncertainties in both the environment restoration process and social progress. Therefore, the rules of the game itself are in a state of flux.

## 7. The relationships between ecology, economics and policy

### 7.1 A simple ecological-economic model

The Baltic ecosystem consists of subsystems that differ in their ecological (e.g., hydrography, climate, biodiversity), socio-economic, cultural, and political features. Therefore, the subsystems react differently to a given environmental impact. Thus, knowledge concerning one regional subsystems cannot be applied in a linear manner to another. Moreover, EUGENE ODUM's thesis: "An ecological system consists of more than the sum of its parts" also applies to social systems. Knowing this, it seems quite impossible to simulate a complex system like the Baltic Sea and its drainage area in a model. Assuming, therefore, that the Baltic Sea reacts to anthropogenic impacts as a whole, we can define the Baltic Sea Area as an "Operating Black Box System" (OBSS) under investigation.

This leads to a further assumption: The Baltic Sea is a basin collecting the natural and artificial emissions from the landscapes and societies located in its drainage basin. The estimated current total loads include about 980,000 tons of nitrogen, 50,000 t of phosphorous, an unknown amount of heavy metals and persistent organic contaminants each year (HELCOM et al 1990). Total loads in terms of biological oxygen demand (BOD) and other substances have been estimated only at subregional levels. These data, however, are of poor quality. They are either lacking or concern, for example, only mixtures of industrial and municipal discharges (HELCOM 1992b). Inputs from non-point sources, and even from some point sources, are mostly unknown. The amounts from natural suppliers can be estimated from the estimations in HELCOM (1990) and others. Besides these uncertainties, environmental impact assessments, the economic valuation, the institutional frame and the political decision making process should be based on the simple model. This avoids the need to allocate impacts to a local point source and provides a better insight for constructing a model of the Baltic Sea region. This approach generalizes the topic, however. The Baltic becomes an ecological unity in the sense of this paper. Second, the Baltic Sea does not only store these emissions. Its ecosystem is also able partly to dispose of them. Moreover, accumulation in the food chain and deposition within the ecosystem affect both the structure and function of the ecosystem. Some inputs return to the Baltic states through fishing (HELCOM 1992b). This may guide us towards an input-OBBS-output model (Fig. 1).

Consequently, energy and/or material balance approaches may apply. However, knowledge concerning details of these processes is lacking (ELMGREN 1989; SWEPA 1990). Since WULFF & STIGEBRANDT (1989, p. 63) reported a total sink of nutrients within the Baltic and an export of about 10% to external sources, an ecological input-output model might describe the present status of the Baltic. This, however, would be a model for the whole Baltic.

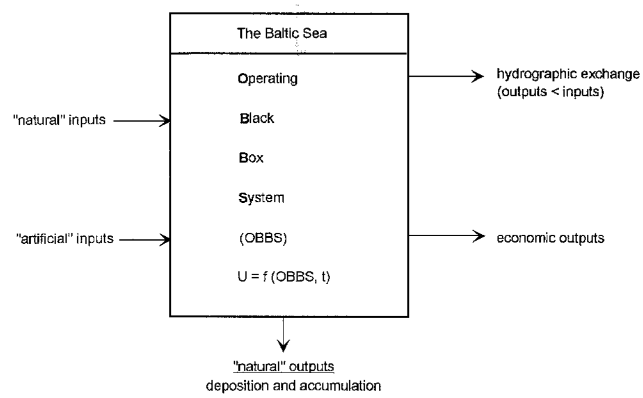


**Fig. 1.** The Baltic Sea as an Input- "Operating Black Box" -Output System.

Third, since ecological processes depend on time scale patterns and the stability or resilience of the system as a whole (HOLLING 1986; COSTANZA 1993; ARROW et al. 1995), we assume further that two states (A and B) can be described with certainty. Although the Baltic Sea ecosystem has received major inputs in previous centuries, it remained in a state of equilibrium (state A, corresponding to 1950). This state is slightly different to the "natural" state, but we have no, or only unsubstantiated, information about this "natural" state.

Moreover, since the Baltic Sea ecosystem is comparatively young, it is hard to say which effects are evolutionary and which are anthropogenic. We may define state A as a "near natural" state in which nutrient supplies stem from weathering in the watershed region. These inputs are defined as "natural ferzilizers". It was only after environmental impacts had increased[5]) and various kinds of artificial suppliers began to appear from the 1950s/60s onwards that the ecosystem responded, after a considerable time lag, in the mid-1970s. After the annual loads ("artifical fertilizers") stopped increasing in the 1980s, the ecosystem became "stable" again (adapted state B). This "stability" was achieved through higher turn-over rates in the ecosystem, a higher rate of primary production, a higher rate of deposition, an increase in biomass and, consequently, a higher demand for dissolved oxygen to supply particular elements of the ecosystem. Thus, the oxygen supply governs the carrying capacity of the whole ecosystem. When oxygen is lacking, the system temporarily becomes instable again. This state C may be regarded as a microbial ecosystem with a low level economic utility. Predictions concerning the future development of the system are impossible. Although, the diversity of this later state is extremely low in comparison to the more healthy states A and to some respect B, "changes in trophic status are extremely difficult to predict exactly because they are caused

[5]) For simplification, toxic substances are excluded from the model.

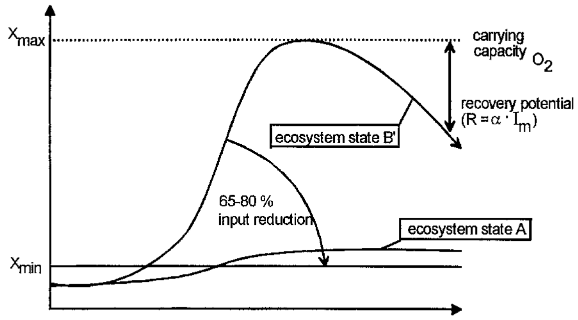


**Fig. 2.** The changes in the Baltic Sea environment. State A refers to the 1950s,while state B refers to 1990s, the dot line indicates the carrying capacity, which is the oxygen capacity in this case.
R = recovery potential; $I_m$ = input mitigation; $\alpha$ = recovery index

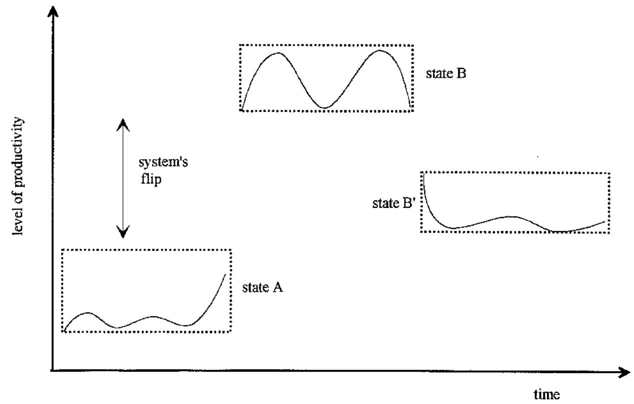


**Fig. 3.** Certain Quasi-Equilibria ("steady-states") of a particular system.

by complex interactions between biological and physico-chemical factors" (SCHIEWER 1995).

Reports concerning the Baltic ecosystem suggest that the critical loads for a sustainable Baltic Sea environment are those reported in the 1930s and 1940s (HELCOM et al, 1990). This, however, should lead to state A. Although this "normal" state of the Baltic Sea ecosystem may have been stable for a few thousand years, the shift towards state B/C shows: the Baltic Sea ecosystem is intrinsically a resilent ecosystem which may be sustainable at various levels of, say, productivity. Changes are therefore highly unpredictable. In view of this, we may assume that the task ahead is to stabilize state B. This in turn seems to imply, however, that self-regeneration (the recovery potential R) must be stimulated, and this will depend on, first, the rate of input mitigation ($I_m$), and second, the recovery capacity of the Baltic Sea itself ($\alpha$). If the recovery potential can sufficiently enhanced through these two factors to equalize the former buffer capacity of the system, the Baltic Sea ecosystem might even return to its previous "natural" state A. In the meantime, the intermediate state B´ may occur (Fig. 2). The transition of the Baltic Sea ecosystem from state A to state B occured during the 1960–80s (Fig. 3). It was caused by all players (littoral states and long-distance air polluters). The Baltic Sea ecosystem adapted to the annual inputs by creating its new stable state B. This intertemporary state B may change to another state C with a lower diversity and, possibly, lower economic value. It seems reasonable to assume that state C will materialize if the former socialist countries achieve the same living standards as the western countries. Therefore, input stabilization should possibly be given long-term priority and might even be realistic in view of potential changes. In addition, equity considerations suggest that emissions from agriculture in the Eastern Baltic Littoral States may increase by a factor of 2. Changes in the industrial sector are currently unpredictable, but some input reductions seem possible in the short term and could stimulate the self-generation capacity of subsystems. The environmental impact assessments of HELCOM (1990), the results of the local impact estimations by JCP (1992), the sectoral impact assessments and the economic potential of the Baltic Sea region (below) permit estimation of the economic value and potential damage. The target "stabilization of state B"also allows calculation of the potential annual total damage and, therefore, the allocation of the total annual costs caused by environmental damage or needed to prevent it. This assumption, however, seems to be very rigid. Hence, an operational basis is needed for the introduction of the polluter-pays-principle (PPP, chapter 9).

The presence or self-stimulation of the recovery potential may be used as part of the trade-off effects to attain state B´. Trade-offs will also occur when non-use values become use values.[6]) This aspect should be taken into account during monitoring to formulate advice on future investments (*information gathering and processing*).

## 8. Risks resulting from the decision making process

Since states A and B are both "stable"states of the ecosystem, the political intention "to assure the ecological restoration ...., and preservation of its ecological balance" (HELCOM 1992a) is obscure insofar as more than one stable system can exist. This raises the question of which balanced state should be attained. Following the basic report (HELCOM 1990), policy seems to prefer state A, that is, the program refers to "active restoration". In other words, the system should be restored the "natural" state seen in the 1950s by reducing at

[6]) Use-values in respect to this paper are those which arises economic benefits in present. Nonuse-values in respect of this paper mean a metaphor of existence and bequest values and include also future economic uses (option values).

least nitrogen and phosphorus loads by 65% or 80% from point source pollution. This is certainly not enough. However, this implies investment in, for instance, sewage treatment facilities corresponding to the Best Available Technology (BAT) with a 96% purification rate. Such a requirement would increase investment and operating costs by factors of 7 and 3 respectively due to the marginal cost theory. Even then, we cannot be sure that it will stimulate the self-regeneration of Baltic Sea subsystems. There are two reasons for this. First, if investments are channeled to single point-source managements, local effects may not be sufficient to influence the whole subsystem or might be neutralized by non-source pollution, such as transportation or agricultural emissions. There is therefore a need for integrated investment management. Second, since acid rain enhances the supply of natural fertilizers, current weathering may not supply the natural fertilizer needed to achieve a stable state A. This could result in an undershoot of the minimum ecosystem's stock. Similar effects can be seen on some parts of the North Atlantic coast and in some Swedish rivers. From the economic standpoint, the application of the mitigation target to every investment raises the risks of investments and the expected returns on those investments. Such uncertainties may be reduced by specifying targets (policy approach), "waiting" (industrial sector approach) or institutionalization (e.g., shared responsibility approach).

# 9. Economic assessments for the Baltic Sea - Consumer approach

## 9.1 Tuning into the subject of economic valuation

The value of the Baltic Sea ecosystem is made up of values based on current economic uses and non-use values. Various methods are used to calculate the economic value of the environment (cf. VATN et al 1994; BISHOP & WOODWARD 1995; BISHOP et al. 1995; BOCKSTAEL 1995; BOCKSTAEL et al. 1995; FREEMAN 1985, 1991, 1995a, b; GRAHAM-TOMASI 1995; READY 1995).[7] They are based on *willingness-to-pay* (WTP), *willingness-to-accept* (WTA) or *consumer surplus* (CS) estimations (HANLEY & SPASH 1993) and assumptions concerning future options or expectations which might arise out of individual preferences in present or future generations. The contingent valuation method expresses valuation approaches for economic and non-economic uses. Expectations and options of future value are weighted against distinct proposals in decision making processes. The valuation is based on previous *Environmental Risk Assessments* (ERA) or *Environmental Impact Analyses* (EIA). These methods supply physical data which are "translated" into economic terms. Economic terms means here an expression in monetary figures which can be used in *Cost-Benefit-Analyses* (CBA). Since, the commodities under consideration are not normally sold in markets, special techniques are used to express the physical damage or risks in a monetary matrix. Thus, consumers are asked in the "*willingness-to-pay*" or "*willingness-to-accept*" approaches. Although the commodities are not sold in markets, they may be essential for some purposes, such as when forests are protected for their ability to purify air or as locations for bird watching, hunting, etc. Such a value may also arise from the option of visiting the Baltic Sea at some time in the future. Therefore, the inclusion of these values (option, existence, bequest values, Figs. 4, 5) is based on the construction of artificial demand functions.

Various techniques have been developed during the past thirty years to estimate values, demand functions for natural resources and, more recently, ecosystems. The contingent valuation method could provide a basis for including these non-used economic values in the current decision making process (BERGSTROM and LOOMIS 1995). And, economically speaking, to introduce these values into cost-benefit-analyses and make sure that options and expectations (future values) are suitably weighted when a decision is made. These techniques need and are based on a comprehensive system of information about the commodity or system under valuation and about the population asked for its preferences concerning a distinct subject. Although the technique involves some risks, the contingent valuation method might yield some insights enabling, for example, estimation of the (accepted) an-

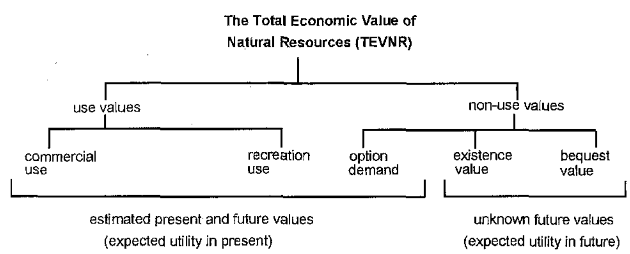


**Fig. 4.** The structural approach to estimate the Total Economic Value of Natural Resources (TEVNR), after LOOMIS et al. (1991).

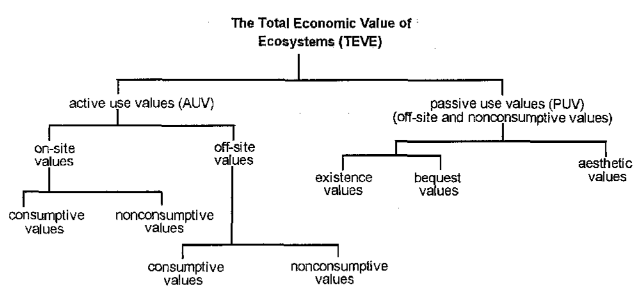


**Fig. 5.** The structural approach to estimating the Total Economic Value of Ecosystems (TEVE), after BERGSTROM et al. (1995).

[7]) Most of these papers summarize the state of the art of distinct methods and distinct conditions in 1995.

nual losses (*willingness-to-accept*) or the annual expected (individual) benefits (*willingness-to-pay*; cf. FREEMAN 1985). The former leads to the *victim-pays-priciple* (VPP) and the latter could facilitate introduction of a *polluter-pays-principle* (PPP) in the Baltic Sea Area. Owing to the unique aspects of economic uses in the Baltic region and the increasing tourism, different techniques must be used to value the Baltic Sea system. However, since the Baltic region is split into two distinct economic regions comprising the northern/western and eastern states respectively, direct measurement of both the *willingness-to-pay* and the *willingness-to-accept* is impossible. Again, separation into subsystems may not reflect the real value of the whole ecosystem.[8])

## 9.2 Estimating the economic value of the Baltic Sea Region

Besides some difficulties and methodological problems, stabilization of the ecological balance (state B) and the introduction of a PPP in the Baltic region require a reasonable estimation of the economic value in both *active-use-values* (AUV) and *passive-use-values* (PUV). Although our results must be considered very provisional, they can be regarded as minimum economic values that will vary with the the structure and certain functions of the Baltic Sea ecosystem. Obviously, direct economic values (and/or benefits) of the coastal strip must be considered separately from those of the entire Baltic Sea region (including the drainage basin). Further, we will exclude PUV from monetarization. This leads, as already stated, to underestimation of the *total-economic-value-of-an-ecosystem* (TEVE), but the consequent inaccuracies may decrease as our future understanding of some trade-offs improves.

However, we assume that, with a WTP approach, individual values may be similar in all Baltic littoral states.[9]) Therefore, this section draws on German studies (HOLM-MÜLLER et al. 1991). Comparative studies covering other littoral states is a task for the future. First, the *environmental budget*, i.e. that share of the monthly household income paid as current charges and taxes used for environmental purposes, is estimated to be about 70 DM monthly.[10]) Second, in comparison, the monthly maximum WTP amounts to 144 DM, or about twice as high as the current impact on the budget. Assuming, that incomes will increase by 2.6% annually, the WTP will rise to 184 DM monthly. Assuming, finally, that the average household consists of 2.6 persons, the potential WTP for the Baltic Sea area is about 34 billion ECU. As real expenditure might be half this figure (cf. HOLM-MÜLLER et al. 1991), the result confirms the estimation of the annual potential damage to the Baltic Sea ecosystem (chapter 10). However, we have assumed that no distinction is necessary between the WTP for water, air, soil, nature protection, etc. Since the Baltic Sea ecosystem is affected not only by the states within its drainage basin, but also by long-distance airborne pollutants, this distinction does not appear reasonable for our approach.

## 10. Estimating the economic value of the Baltic Sea Area - Productivity approach

These analyses are based on estimations of demographic data for the Baltic Sea region (The World Resources Institute 1994). In addition, German labour productivity data have been taken into account in assessing economic performance potential (Institut der Deutschen Wirtschaft Köln 1995). However, the total labour force is about 28.5 Mio., while the current economic performance basing on individual labour performance within the Baltic region is at least 1,100 billion ECU annually. This is about 40% of the potential total economic performance if Eastern Baltic Littoral States were as effective as the Western ones.

The realization of economic benefits in the coastal region depends on both distinct sectoral efforts towards a healthy environment and the economic performance potential of each sector. Therefore, sectoral utility was analyzed before calculating the potential losses. Benefits can be expected to accrue at least from the use of the Baltic Sea as a resource supplier for waterborne transport, energy production, fisheries and fish processing, tourism, environmental industries, extraction of nonrenewable resources, climate and nature conservation. As the data base is very limited, total annual benefits may exceed 35 billion ECU. However, investments in environmental industries, for example, are difficult to assess owing to their ambiguous character. In addition, transport does not always depend on a healthy environment. Since these results probably underestimate the annual benefits, they may at least serve to calculate an estimated annual loss risk. Moreover, these data do not include the benefits estimated to accrue in the value by settling cities on or near the coast (KÖHN 1995).

On the other hand, loss of the present stage of the Baltic Sea environment due to human impacts may jeorpardize economic benefits in the coastal strip economies or even cause damage worth at least of 35 billion ECU.

[8]) "By evaluating only those components of the ecosystem that have immediate value to individuals, and focusing on short-term changes in the ecosystem, this practice ignores the fact that changes in ecosystems play out over time and space and may indeed be irreversible. ... Studies either examine aggregate national data or they pursue site-specific case studies ... Even the "same" wetland in different localities will have different value (BOCKSTAEL et al. 1995).

[9]) This, of course, is not the case as differences in per capita GNP will be greatly influence the results. However, the WTP should show the potential individual values.

[10]) The calculation is based on annual public expenditures for environmental investments and operating costs in 1985 (HOLM-MÜLLER et al. 1992, p. 24). Assuming a linear annual increase of 3% in the price index, about 95 DM/month had to be paid in 1995.

## 11. Mitigation efforts to restore Baltic Sea – sources and sectoral impacts

The political target of JCP includes mitigation efforts (Table 1). These should be translated in sectoral mitigation strategies (Table 2).

Although, these figures show the divergence between political goals and reality, these figures do not include the compensatory effects of the growing economies in the Eastern Baltic States (chapter 12).

Tables 1 and 2 include sources of nonpoint pollution. These rates of pollution are not easy to mitigate. In addition, huge uncertainties are encountered as regards causes, accumulation and release effects as well as economic management when dealing with these specific kinds of human impact on the environment. Since these are crucial components of the restoration game, the need for economic or political regulation is obvious. This, however, implies new institutional frameworks as well as the application of appropriate economic instruments (chapter 13, 14).

## 12. Responsibilities for a(n) (un)sustainable development in the Baltic Sea Region

Chapter 11 dealt with the level of human inpacts on the Baltic Sea and efforts to mitigation them. This chapter will deal with economic performance in the Eastern and Western Baltic Littoral States. National economic performance will be described by means of a set of available economic indicators. Per capita availability of economic supplies will be estimated in a second step. Then, the relative per capita equipment will be used to show the per capita impacts and the potential economic growth rates assuming equal rights in consumption in East and West (Table 3). Without dematerialization of production and consumption (SCHMIDT-BLEEK 1994), if standards of living converge, environmental impacts can be expected to increase at the rate shown by the ratios (Table 3, column 4). Therefore, assuming that production and consumption will converge and if equity for the present generation is crucial to sustainability, one may estimate first the threat of unsustainable development in the Baltic Sea region,

**Table 1.** Species and sources of pollution and mitigation efforts.[1]

| Species of pollutants | Source of pollution | Share of pollution |
|---|---|---|
| Nitrogen | air borne | 51%, about 60% stem outside the water drainage basin |
| | water borne | 49% |
| Phosphorus | deposition | 11% |
| | water borne | 89% |
| Chemical compounds | (causal chemical industry) | 100% |

[1] Data base on HELCOM (1990, p. 6, 22).

**Table 2.** Impacts of economic sectors and mitigation efforts.

| Economic sector | Share of pollution | Mitigation efforts |
|---|---|---|
| Municipal sewage | about 40% of water borne fertilizer inputs in human equivalents | 80% in phosphorous<br>65% in nitrogen |
| Agriculture | about 60% of water borne fertilizer inputs in human equivalents | 80% in phosphorous<br>65% in nitrogen |
| Agriculture | about 11% of phosphorous inputs (deposition)<br>about 15–20% of air borne nitrogen inputs[2] | 80% in phosphorous<br>65% in nitrogen |
| Industry | causal all inputs of pestizides, organochlorines etc. | 90% reduction |
| Industry | 15–20% of air borne nitrogen inputs | 65% reduction |
| Transportation | 35–75% of air borne nitrogen[3] | 65% reduction |
| Tourism | ? | related to municipal impacts |

[2] According to ENQUETE-Kommission, Vorsorge zum Schutz der Erdatmosphäre, Deutscher Bundestag, Drucksache 11/8030, p. 31, calculated in green-house gas discharges.
[3] HELCOM (1992, p. 3–26): Institut der Deutschen Wirtschaft Köln (1995, p. 104).

**Table 3.** Indicators for Economic Performance, Land Use Intensities in the Baltic Littoral States and Inequity Relations of the Eastern to the Western Baltic Littoral States.[4]

| Indicator | Eastern Baltic States, in physical terms [potentially] | Western Baltic States, in physical terms [potentially] | Ratio Eastern to Western Baltic States (West = 1) |
|---|---|---|---|
| land area (000 hectares) | 66,418 | 80,077 | 0.82 |
| population (000 inhabitants) | 55.85 | 23,55 | 2.37 |
| – population density (1993, per 1,000 hectares) | 840 | 294 | 2.86 |
| – urban population as % of total, 1995 | (70.5) | 79.2 | 0.89 |
| – total labour force 1989-91 (000) | 17,292 | 11,296 | 1.53 |
| – annual economic performance (in million $US, as productivity of gainful employment in 1994)[5] | 354,840 | 903,680 [2,129,040] | 0.39 |
| – in agriculture (% of 1989–91 labour force)[6] | 27 | 5 | 5.4 |
| – in industry (% of 1989–91 labour force)[7] | 37 | 31 | 1.2 |
| – in service (% of 1989–91 labour force)[8] | 36 | 64 | 0.56 |
| GNP per capita ($US/a) | 3,087 | 23,085 | 0.13 |
| annual growth rate of GNP per capita | 2.6 | 2.4 | 1.08 |
| industrial environmental impacts (as equivalent of $CO_2$-emissions, million metric tons)[9] | 798,164 | > 250,000 | 3.19 |
| – industrial $CO_2$-emissions per capita (metric tons/a)[10] | 11.44 | 11.33 | 1.00 |
| agriculture | | | |
| – cropland (000 hectares, 1989–91) | >20,000 | 9,181 | 2.17 |
| – cropland (hectares per capita) | 0.38–0.94 | 0.15–0.51(0.37) | (2) |
| – average annual fertilizer use (kg per hectare of cropland) | 52–151 (113) | 113–520 (262) | 0.43 |
| – average fertilizer use (metric tons) | (3,000,000) | 2,058,468 | – |
| – annual pesticide consumption (metric tons)[11] | (>20,568) | (>12,000) | – |
| – average yields of cereals (kg per hectare, 1990–92) | 2,253 | 4,708 | 0.48 |
| – average yields of roots and tubers (kg per hectare, 1990–92) | 12,988 | 28,993 | 0.44 |
| – livestock population in human $NO_x$-equivalents (000)[12] | > 80,000 | > 47,000 | 1.7 |
| – cattle (000, 1990–92 ) | > 15,500 | > 8,300 | 1.9 |
| – sheep&goat (000, 1990–92) | > 5,480 | > 900 | 6.0 |
| – pigs | > 30,000 | > 15,400 | 1.9 |
| – equines | > 1,000 | > 180 | 5.6 |
| – chicken | > 100,000 | > 45,000 | 2.2 |
| – grain fed (% of total grain consumption, 1990–92)[13] | (47) | (70) | 0.67 |
| transportation (persons per vehicle 1991) | 8 | 2 | – |
| – environmental impacts in $NO_x$-equivalents (% of total $NO_x$-emissions) | 35 | 65 | – |
| tourism (summer cottages per 000 inhabitants) | – | 37.4–76.4 (64.4) | – |

[4] The calculations base on data of The World Resource Institute (1994, table 11.7, 11.8, p. 202; table 15.1, p. 257, table 16.1, p. 269; table 17.1, p. 295; table 17.2, p. 286; table 18.1, p. 293; table 18.3, p. 297) and The Third Conference of Ministers of Spatial Planning and Development (1994, p. 24).

[5] Assuming a hourly employment productivity of $US 40, data base on Institut der Deutschen Wirtschaft Köln (1995, p. 29, 30).

[6] Data for Poland only.

[7] Data for Poland only.

[8] Data for Poland only.

[9] The German industrial emissions are calculated for Mecklenburg-West Pomerania and Schleswig-Holstein.

[10] Estimations base on data for the former USSR.

[11] Data for Poland only.

[12] The calculation bases on the assumption that cattle (1.0), sheep & goat (0.5), equines (1.0), pig (2.2), and chicken (0.1) cause an equivalent to $NO_3$-emissions of 1.0 human (see PEARL 1996).

[13] Data for Poland only.

second the past and present responsibility for damage to the Baltic Sea environment in a national perspective, third the need for and necessary rate of technological progress for reducing production and consumption (dematerialization or sufficiencey revolution), and this finally will enable the establishment of an institutional framework to overcome the obstacles of an unsustainable growth mania in the economy.

## 13. Funding Baltic Sea Region sustainability

The JCP target of restoring the ecological balance of the Baltic Sea environment by reducing environmental impacts to levels similar to those in 1930–40 appears unrealistic one in view of the economic indicators and estimates of growth potentials in the Eastern Baltic Littoral States at least in the period (1993–2012) envisaged by the program. However, impact mitigation impacts is doubtless necessary to sustain the Baltic Sea environment. In addition, simple models (chapter 7) suggest that at least some recovery of the Baltic Sea ecosystem might be expected. Therefore, it may be implied that the first step towards sustaining the Baltic Sea ecosystem involves the subtarget of stabilization of state B. Economically speaking, this means avoiding further damage by implementing suitable technologies and both economic and political institutions. Avoiding further damage corresponds at least in theory to mitigation strategies on the same scales. In financial terms, this involves – with reference to economic sustainability – reinvesting income from the economic process in mitigation strategies. Although, this will lead only to financial equilibrium it may help to build up institutions that will reduce the uncertainties when setting intermediate targets and in process monitoring.

Since the damage function estimates annual potential losses of >35 billion ECU and the *willingness-to-pay* Matrix may yield about 34 billion ECU annually, a financial equilibrium may be achieved by institutionalization of the *polluter-pays-principle*. However, the populations in the Eastern Baltic Littoral States are unable to pay this share. Chapter 14 will focus on compensation.

However, the *victims-pay-principle* will be excluded as unrealistic. Also, about 60% of airborne pollution does not stem from beneficiaries of the Baltic restoration process. But as at least four EU states (Denmark, Finland, Germany and Sweden) will benefit from the Baltic Sea restoration process, other pollutant source countries in the EU will ultimately also be involved in Baltic Sea restoration. Therefore, it seems reasonable to assume that the Western Baltic Littoral States that also acquired economic benefits from the environmental degradation of the Baltic Sea will at least to some extent be willing to subscribe to a Baltic Sea Restoration Fund rather than pay for mitigation strategies among comparatively wealthy nations further west. Moreover, compensation payments from the Eastern Baltic Littoral States to the wealthy nations in the west may only be simulated. In addition, the game may be broadened from a consumer game (chapter 9.2) to one involving joint participation, including economic sectors such as industry and financial institutions (chapter 14).

Considering the economic indicators (chapter 12) the following assumptions for the PPP may hold for the institutional structure. The ratio between per capita GNP in the Eastern and Western Baltic Littoral States shows that although 2/3 of the population lives in the Eastern States 75 per cent of the GNP is created in the Western States. The ratios for the impacts of the various economic sectors are as follows (total amounts, West:East):
Agriculture 2 : 1; Transportation 2 : 1; Sewage discharge 1 : 2; Industry 1 : 1; Tourism 3 : 1.

Western impacts account for about 2/3 of the total. This is about 2/3 of the PPP payments are due to the Western Baltic Littoral States (about 22 billion ECU). These figures also show the following distribution in economic sectors (production and consumption, Fig. 6). In addition, a GNP based tax is proposed. This would reflect direct interest in the form of an incentive to mitigate impacts on a shorter time scale. This portion of the tax would decreases as the environmental improves in absolute terms and as the relative shares of the Eastern and Western Baltic Littoral States converge.

Consequently the share of the Eastern Baltic Littoral States would be about 1/3 (about 12 billion ECU). However, the sectoral shares are different, as is the participation of financial institutions. Moreover, the lower per capita GNP, the smaller the share of the GNP based tax (Fig. 7).

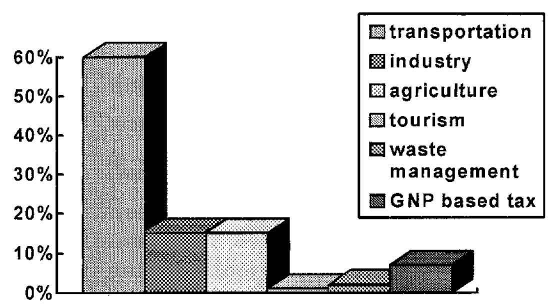


**Fig. 6.** Polluters Pay in Western Baltic Littoral States.

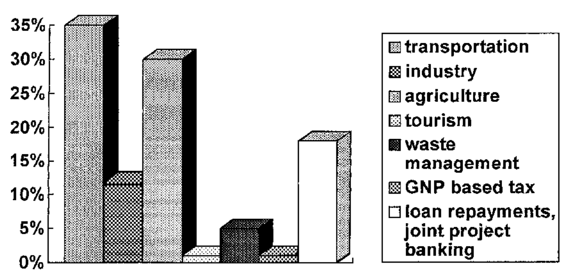


**Fig. 7.** Polluters Pay in Eastern Baltic Littoral States.

## 14. Institutional structure for Baltic Region sustainability

Since the regulation of environmental policy has often led to inefficient ecological outcomes, this paper focuses on a strong economic approach: the greatest possible deregulation and an invitation to all social players to take part in the Baltic Sea restoration process. However, uncertainties appear in both the regulatory and the deregulatory approach. But uncertainties may give rise to additional costs for transactions in dealing with resources and socioeconomic activities (NORTH 1988). Least cost planning in the case of Baltic Sea restoration, therefore, is a challenge to policy and economic theory.

ELENOR OSTROM (1990, 1992) shows in her analyses concerning common property resources that institutions may "govern the commons" at least in a one-resource-one-commodity approach. She states (1992, p. 9): "... We now have a relatively good understanding of the emergence of norms, rules, and property rights regimes in simple, small, and isolated natural resource systems characterized by:

- a small and stable set of users able to communicate on a face to face basis,
- predictable and easy to measure flows of benefits and costs, and
- symmetry of information, asset structures, capabilities, and preferences.

... Large natural resource systems, particularly those that cross national borders involve substantial difficulties. These are associated with large and heterogeneous numbers of individual and corporate actors and the difficulties of making creditable commitments. Further may natural resources, particularly multi-species fisheries and forests, involve complex transformation functions whose structure is hard to determine. ... And, resources such as forests and the atmosphere involve such long time horizons that the value of future benefits and harms are difficult to assess. ... We ... will continue to use game theory ..."

The Baltic Sea sustainability approach is a multi-species, multi-resource approach with heterogeneous participants and a long time horizon. This implies that outcomes are unpredictable and often uncertain. It also implies that priority must be given to erecting new institutions to "govern" the common property resource "Baltic Sea" and the inherent uncertainties of its systems and processes. The main structure of the Baltic Sea negotiation game may as shown in Fig. 8.

Players in the Baltic Sea sustainability game are beneficiaries of the sustaining process, those who will benefit directly from environmental improvements and those who, for these reasons and to save costs, are willing to pay and participate. The game structure may be based on an ongoing negotiation process, should be hierarchically ranked, and involves the "players" given in Table 4.

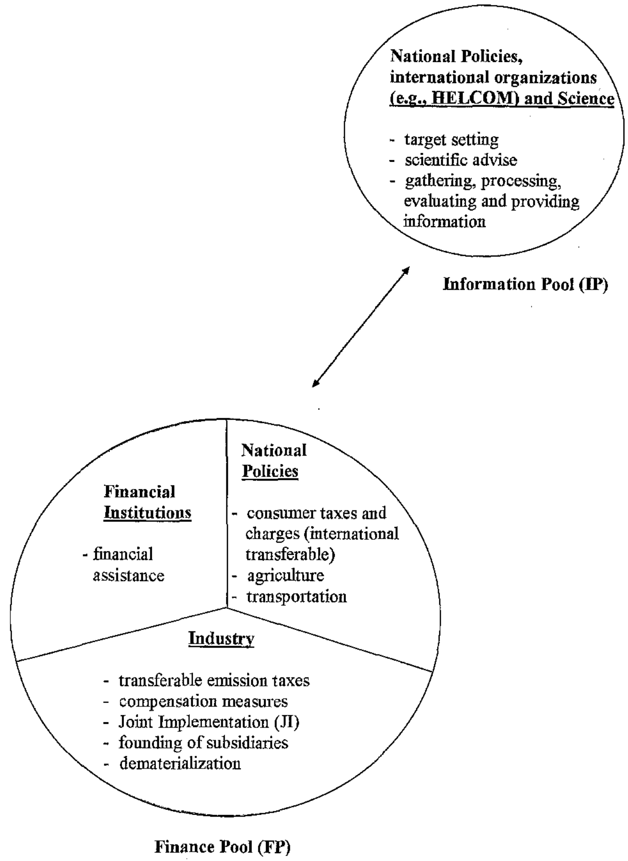


**Fig. 8.** An opportunity for an institutional frame to govern the Baltic Sea region sustainability process.

**Table 4.** Game structure.

| | | | |
|---|---|---|---|
| Supergame: | Finance Pool | – | Information Pool |
| Game I: | within the Information Pool | | |
| | National Policies | – | National Policies |
| | National Policies | – | Science |
| Game II: | within the Finance Pool | | |
| | National Policies | – | (National) Economic Sectors and Consumers |
| Subgames: | | – | Agriculture |
| | | – | Industry |
| | | – | Transportation |
| | | – | Tourism |
| | | – | Waste Management |
| | | – | Consumer Taxation |
| | National Policies | – | Industries |
| | National Policies | – | Financial Institutions |
| | Industries | – | Financial Institutions |
| | Industries | – | Municipalities |
| | Industries | – | Industries |
| | Municipalities | – | Financial Institutions |

The game structure conform's to KÖHN's (1990) proposals for "user-complexes" for certain resources within the Baltic Sea region and LUNDGREN & MATTSON's (1995) proposals for industrial networks to support industrial change in the transition processes taking place in the Eastern economies. The *Information Pool* may supervise the sustainable development process in the Baltic Sea region by setting targets, providing scientific advice in both the natural and social sciences, monitoring the processes and gathering, processing, analyzing and disseminating information to the *Finance Pool*. The players in the *Finance Pool* will develop inplementation strategies and act accordingly. Their negotiations will focus on cooperative funding and creating associations of stake holders at the local, regional, national and Baltic Sea region levels. National policies will be responsible for consumer integration, agriculture and transportation, while industry will receive an international focus. Industrial interests will be invited to set up subsidiaries in the Eastern Baltic Littoral States, to provide funds for compensation where further investments in their own production facilities are of marginal utility in relation to the compensation needed elsewhere and to pay taxes to the *Finance Pool* for environmental damage, to implement environmentally sound technologies (joint implementation, partly repaid from the tax pool to which they contribute), and so on. Financial institutions will be invited to offer financial assistance (cf. KÖHN 1999).

## 15. Concluding remarks

This paper raises questions concerning an approach for achieving sustainability of the Baltic Sea. It shows how different sustainability concepts interact. Since the Baltic Sea is a multispecies, heterogeneous common property resource, the environmental sustainability concept conflicts with social goals such as convergence between the social and economic systems in the Eastern and Western Baltic Littoral States. The transition process and system-inherent changes in time involve uncertainties and economic risks for investors. However, management of the common resource by a participative network of institutions will reduce the uncertainties and encourage investment in the Baltic sustainability process. However, this process will be long.

The paper uses various approaches offered by economics theory. It purposely avoids detail as its principal aim is rather to give a general analysis of possible ways to make regional sustainability feasible.

As the studies presented here are based on an on-going research project, the results given here must be regarded as provisional.

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